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ABSTRACT

Many attempts have been made to define the objectives of science. Now, in the latter part of this decade, many questions still remain unanswered. The goal of this paper is to collect information on the objectives of science education and to relate this information to the role of the classroom teacher. Educators and researchers suggest that science objectives should be associated with learning the processes and concepts of science. The body of factual scientific information is too great to make educational objectives hinge on the acquisition of knowledge alone. Many educators recommend objectives that emphasize activity-oriented, problem-solving kinds of skills. The National Science Teachers Association (NSTA) recognizes scientific literacy as a major goal. The effects of these kinds of objectives on the classroom teacher are great. Emphasis on learning skills, individualizing instruction, and identifying values are important components of teaching science today. Regardless of the specific branch of science, teachers need to keep in mind those skills, such as problem-solving, which are common to all education. Included is a selective bibliography. (MA)

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SCIENCE OBJECTIVES AND THEIR IMPLICATIONS CONCERNING CLASSROOM TEACHING

A STUDY

PRESENTED TO

DR. ROBERT FISHER

by

TERRY DIXON

June, 1977

SE 023 055

I. INTRODUCTION

Mr. and Mrs. Smith are going out to buy some new furniture for their small trailer.

Lori and Christy, ages 10 and 12, are going out to buy new bicycles with the money they have earned on their paper route, but they can't decide which one to get. They have seen so many different ones.

Dr. John Wood is about to go into the operating room to remove a tooth pick a small boy has swallowed. The boy can breathe, but can't swallow. The doctor has to decide where to operate.

Mrs. Winter, a housewife, is ironing when suddenly the iron goes off, but the lamp, which is plugged into the same socket, is still working.

Mr. Brodrick has worked on the NASA team for ten years now. Last week he was assigned to head a committee to decide what equipment the astronauts will have to carry when they land on the planet Pluto. A surveyor satellite will be sent up to find out vital information. Dr. Brodrick must decide what he needs to know to accomplish his objective.

Even though the characters in the above stories are fictitious, their problems aren't. Today many people face the same or similar problems daily. Problems so simple as trying to decide what bicycle to buy, or so complex that a person's life may be determined by the outcome.

With this wide range of problems in mind, science educators need to take a new look at the goals of science education.

These problems are examples of some situations that brought

about my personal need for some answers to some basic questions concerning science education.

The object of this paper, therefore, is to gather into one body recent information concerning suggested science objectives and to describe what implications I feel it has concerning the classroom teacher.

II. SUGGESTED OBJECTIVES OF SCIENCE EDUCATION

As one begins to search for the basic objectives of science education, he suddenly realizes the broad area it covers.

For example, Washton states:

> "Throughout my various interviews, discussions, and correspondences with scientists and science educators, I noted in almost all instances the need for a greater emphasis on technology in our science courses."[1]

Yet a group of principals and teachers who were surveyed by the Public Educational Development Center, Wilkes College, in Pennsylvania,

> ". . .seemed to place the highest priority upon developing critical thinking skills, curiosity, and problem-solving skills."

The teachers and principals went on to show that

> "General student intellectual skills are expressed as their main concern."[2]

Williamson summed it up when he said,

> "Regardless of the efforts that have been made in the past two decades to identify objectives and content, we enter the last quarter of this century with many unanswered questions, unsolved problems, and unresolved issues."[3]

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1. Nathan Washton. Teaching the Impact of Science on World Technology. A paper presented at the 49th annual meeting of the National Association for Research in Science Teaching, April 23-25, 1976, at San Francisco, California, p. 9.

2. Overrcero and Belluci. An E D C Report: Science Teaching in Pennsylvania Public Elementary Schools. Wilkes-Barre, Pennsylvania: Public Educational Development Center, Wilke College 1973, p. 5.

3. Stan Williamson. Issues in Science Education: Changing Purposes of Science Education, 1976, p. 9.

With the realization of the broad area of science education let's take a look at what objectives have been suggested by educators, researchers, and organizations in writings and studies.

Educators and Researchers

Dewey said,

> "The aim of education is to be found in the process itself and not as a final goal to be reached."[4]

This seems to be the direction taken by most science education today, as can be seen by looking closely at the new science curricula. Cleminson, Moore, and Jones state in "Guidelines and Competencies for Elementary Science Educators" that

> "The process-inquiry skills are skills which instructors believe are fundamental for elementary teachers and children. They are appropriate for students at all grade levels and provide a basis for developing process inquiry skills."[5]

They go on to list these skills as observing and inferring, classifying, measuring, recognizing and controlling variables, organizing data, hypothesizing, and replicating.

Sheehan seems to agree with Cleminson when he answers the question, "What does the scientist do when he is doing science?"

> "He observes, measures, hypothesizes, predicts, interprets data, defines operationally, and performs a number of other mental and tactile operations."[6]

4. Cleminson, Moore, and Jones. Guidelines and Competencies for Elementary Science Education N. Y., N. Y.: MSS Information Corporation, 1974, p. 9.

5. Ibid. p. 9

6. Joseph T. Sheehan, Learning Process in a Basic Science Curriculum, a paper presented at the annual meeting of the American Educational Research Association, April 17, 1974, at Chicago, Illinois, p. 3.

Piaget seemed also to agree with Clemmson, Moore, and Jones when he gave the following as the aim of education:

> ". . . to create men who are capable of doing new things, not simply of repeating what other generations have done--men who are creative, inventive, and discoverers."
>
> ". . . to form minds which can be critical, can verify and not accept everything they are offered."[7]

He goes on to say in summery,

> "We need pupils who are active. . . who learn early to tell what is verifiable and not what is simply the first idea to come to them."

In the Phillipines, they have schools commonly called barrio high schools,[8] where because of necessity, the students not only develop scientific experiments in general science, biology, and physics, but are taught how to use what they learn in these and other courses to improve their earnings.

Why do they need to improve their earnings? Barrio youth who continue past the sixth grade have to support their own high school. They are enabled to do this by making use of what they learn in science to earn their way through school.

The schools have developed a procedure in the elementary grades that is now being applied at the high school and college levels where in addition to the practical application, the students are taught to consider, as well, the welfare of their classmates and other people in their neighborhood and community.

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7. Williamson, op. cit. pp. 9-10

8. Orata, P. T., "Humanizing Science to Save the World from Destruction." International Review of Education. Number 22, 1976, p. 98-99

The procedure includes the following phases:

Phase 1--The students are divided into groups of about ten at the beginning of the school year, to go out into the community to discover local problems.

Phase 2--The students then develop experiments to discover a principle that may be implemented to solve their problem.

Phase 3--They carry out experiments and draw conclusions.

Phase 4--A plan for appropriate application is carried out.

The barrio school seems to be a prime example of what Fischler meant when he summed up the change in science education. He said,

> "The emphasis has changed from the ability of a child to regurgitate scientific facts to the ability of a child to utilize his newly discovered concepts in carefully selected learning situations."[9]

Harbeck, in her article, "Is Science Basic, You Bet", seems to agree with Fischler. She says,

> "When science is learned through an activity-centered approach, it becomes a vehicle for learning skills that are necessary for everyday life. Children need to learn how to observe, describe, classify, measure, hypothesize, and experiment. They must not only learn the rules but also be able to apply these generalizations to new situations."[10]

Some educators and researchers felt that objectives should be tied to physical and mental growth. Robinson states that Eric Erikson and, more recently, James Loevinger have provided dynamic theories of psycho-social and ego development.

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9. A. S. Fischler, Science, Process, The Learner: A Synthesis. Science Education 49:5, 1965, p. 402.

10. Mary B. Harbeck, Is Science Basic? You Bet It Is, Teacher, November 1976, p. 22.

Robinson states,

> "Who the target population is has to be determined prior to setting curricular goals. I make this assertion because in my view the characteristics of the learners are limiting factors for what educational goals there may be. By characteristics of the learner, I mean their physical patterns, the development of large and small muscle coordination, the onset of puberty, and the adolescent growth spurt are factors that should not be ignored in setting curriculum goals."[11]

McBeth conducted a study which would tend to support Robinson's contention.[12]

McBeth asked children aged 3-8 to sort a number of paper shapes into subsets. It was noted that there was a strong tendency at all age levels to sort by form rather than by color. McBeth suggested that the preference for form develops before formal schooling.

Results of a study by Gunter concerning the sequencing of units in a college biology course utilizing an audio-tutorial approach seemed to say we will do a more effective job of instruction if we can learn in advance what the student already knows and sequence the learning activities to capitalize on that prior knowledge.[13]

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11. James T. Robinson, Critical Issues in Science Education, A paper presented at the annual meeting of The Association for Education of Teachers of Science, March 1976, p. 4

12. Dudley Herron and others, A Summary of Research in Science Education, 1974, N. Y., N. Y. John Wiley and Sons Inc., December 1975, p. 17.

13. Herron, op. cit. p. 24

Ogden in his study, "A Chronological History of Selected Objectives for the Teaching of Secondary School Chemistry in the United States During the 1918-1972 Period as Reflected in Periodical Literature,"[14] classifies his statement of objectives into the following categories:

(1) Knowledge objectives--those objectives advocating the attainment of factual or conceptual material for its own sake.

(2) Process objectives--those conveying an understanding and use of the methods and technique of schools.

(3) Attitudes and interest objectives--those concerned with developing an appreciation of the contribution of and nature of the scientific enterprise, desirable attitudes involving science and scientists, and lasting professional and avocational interest in the student.

(4) Cultural awareness objectives--those dealing with the interworkings of science and society or the cultural implications of science for society.

Ogden stated in his conclusion,

> "Although yearly fluctuations existed with respect to both the numbers of articles and statements concerned with the objectives for teaching secondary school chemistry that appeared in the literature of 1918-1972 period, the number of distinct objective types remained fairly constant."

He further states,

> "Prior to sub-period 4 (1945-1957) six objective types (scientific methods of thinking; major facts, principles, concepts or fundamentals; specific topics in chemistry; scientific habit or attitudes; the application of chemistry to daily life; and processes, skills, and techniques of inquiry were always the six most frequently referred to in the literature."[15]

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14. William Ogden, A Chronological History of Selected Objectives for the Teaching of Secondary School Chemistry in the United States During the 1918-1972 Period as Reflected in Periodical Literature. A presentation at the annual meeting of The National Association for Research in Science Teaching, Chicago, Illinois, April 18, 1974, p. 5.

15. Ibid. p. 6.

ORGANIZATIONS

Many organizations have suggested objectives for science educators.

The National Science Teacher's Association Board of Directors at its annual meeting, July, 1971, stated,

> "The major goal of science education is to develop scientifically literate and personally concerned individuals with a high competence for rational thought and action. This choice of goals is based on the belief that achieving scientific literacy involves the development of attitudes, process skills, and concepts necessary to meet the more general goals of education, such as:
>
> Learning how to learn
> Learning how to attack new problems
> Learning how to acquire new knowledge using rational process
> Building competencies in basic skills
> Developing intellectual and vocational competence
> Exploring values in new experiences
> Understanding concepts and generalizations
> Learning to live harmoniously within the biosphere
>
> The goal of science education should be to develop scientifically literate citizens with the necessary intellectual resources, values, attitudes, and inquiry skills to promote the development of man as a rational human being."[16]

The state of North Carolina's Department of Public Instruction in their "State Assessment of Educational Progress in North Carolina, 1973-74" state their objectives for assessing science education (3rd grade) as follows:

> A knowledge of life science, physical science, earth-space science, comprehension of life science, comprehension of earth-space science, application of life science, application of physical science, Knowledge of scientific processes and beliefs, attitudes and experience.[17]

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16. _____, NSTA Position Statement on School Science Education for the 70's. A paper presented to the NSTA Board of Directors at its annual meeting, July, 1971, p. 1.

17. _____, State Assessment of Educational Progress in North Carolina, 1973-74. North Carolina State Department of Public Instruction Document, February 1975, ps. 16-23

Three major programs of science instruction have evolved over the last fifteen years, each designed to reach a specific overall objective.

The Science--A Process Approach program chose to organize their program around thirteen thinking processes scientists use in investigating life, energy, and matter. Specific hands-on activities were arranged in simple to complex sequences for each process. Subject matter content was introduced as needed in advance of process learnings.[18] The objective was to teach thinking process skills.

The developers of Elementary Science Study constructed 56 units of instruction that reflected their child-centered, humanistic concerns. Each unit was built around a different topic appealing to children's curiosity about some aspect of their environment and was designed to help them learn how to explore it.

Unlike SCIS and SAPA neither scope nor sequence was recommended for the units. Instead teachers were invited to organize the units into whatever framework best suited their situation.[19]

The Science Curriculum Improvement Study built its curriculum around a dozen broad concepts that seemed to reflect the nature of the modern physical and life sciences. Each concept became the organizer for one unit of instruction. Activities were designed to combine concept and

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18. Peter C. Gega, Directions in Elementary School Science. Teacher, November 1976, p. 59.

19. Ibid

process learning in an organized sequence. Activities were designed to suit children's developmental stages while clearly identifying their experiences.[20]

The 8th Annual Gallup Poll of the Public's Attitude Toward the Public Schools gave indications of what the public felt should be major objectives in education.

In response to the question,

> "Do you think that the school curriculum should give more emphasis or less emphasis to careers and career preparation in high school?"

80% said more emphasis should be given to careers in high school.

In response to the question,

> "Should more information concerning careers be given in the elementary schools?"

More said yes than no.[21]

From the literature included in this paper it is evident that educators, researchers, and organizations agree on a general goal for education. That goal, I feel, was best expressed by the NSTA:

> "The goal of science education should be to develop scientifically literate citizens, with the necessary intellectual resources, values, attitudes, and inquiry skills to promote the development of man as a rational human being."[22]

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20. Ibid.

21. George H. Gallup, Eighth Annual Gallup Poll of the Public Attitude Toward the Public Schools, Phi Delta Kappan, October 1976, pp. 191-192.

22. State Assessment op. cit. p. 16.

III. IMPLICATIONS: THE CLASSROOM TEACHER

The acceptance of the objectives of science education as mentioned in this paper have broad affect on the classroom teacher. Today's teacher must be trained far better than the teacher of the past because of the wide area that modern science education covers.

Today's teacher must be able to recognize the dynamic properties of science so that he can place emphasis in his teaching on process and skills, rather than on the memorization of facts. He must also be aware of the ability and growth of the student he teaches so that he may challenge him to his full capacity without expecting more from him than he is developmentally capable of doing.

The classroom must instill in the student the idea of questioning all that is around him, of wanting to seek out answers, while at the same time providing the atmosphere to solve these problems. The classroom teacher must also be aware of the broad uses of problem-solving skills in society today, problems so small as deciding what bicycle to buy or so important that a life may hang in the balance. Awareness of careers in science must be present, so that the skills taught in science will be useful in the future as well as meaningful in the present.

Above all, the science educator must recognize the individuality of his students of science and encourage them in the areas of science in which they are interested. Classroom teachers who teach branches of science must keep their eyes opened to the broad goal of science and not become so involved and bogged down with the teaching of specific branch skills that they forget about their broad goal.

Most of all, the science educator must be willing to meet the challenge of keeping up with science education as it changes to meet the needs of future generations.

In almost all the research and literature mentioned in this paper, probably none has greater implication than those concerning values. In most of the recent literature concerning science education, "values" or "social effects" have been mentioned as new goals on which to base education. Orata states in the note section of the "International Review of Education",

> "It is time to teach pupils, from preschool age up to university, to learn to perform their duties and responsibilities as well as to demand that their rights be respected. There is no better field to which this principle should be applied than science. Unless the young are taught science so that they will use their knowledge of scientific principle and procedure to improve their livelihood and to help others as well, the chances are that they may not apply it at all or, if they do so, they will use it to help only themselves, and in all too many cases, at the expense of others.
>
> The only alternative is to teach science, and other subjects as well, differently. Besides leading the pupils, through so-called "process" or "conceptual approach", only to discover facts and principles for right living, by experiment, observation, or reading, they should also be taught to apply what they learn to live well and rightly with their neighbors everywhere."[23]

Brown states in his paper, "Teaching the Impact of Science on World Technology,

> "The high cost of this food-price instability is economic, political, and social. Hence, the teaching and learning of

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23. Paul E. Blackwood, Science Teaching in the Elementary School, U. S. Department of Health, Education, and Welfare, U. S. Government Printing Office, Washington, D. C., p. 97

> science need to be reevaluated in terms of intelligent citizen decision making, taking into account the economic, political, and social implications of science and technology."[24]

Orata states in the note section of "International Review of Education":

> Teachers ". . . must go far beyond teaching the student to think scientifically and to discover scientific principles. They must teach them to act appropriately and to apply what they discover or learn, considering the consequences of what they contemplate doing to others as well as to themselves."[25]

Implications are that a massive reevaluation of programs is about to begin, to find out how well they teach scientific and social values. In effect the implication is that science educators must no longer be satisfied with just teaching concepts and processes without also teaching their social, political, and economic effect.

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24. Washton, op. cit. pp. 5

25. Blackwood, op. cit.

SELECTED BIBLIOGRAPHY

I. Periodicals.

1. Anderson, Elaine J. Behavioral Objectives, Science Process and Learning From Inquiry-oriented Instructional Material Science Education, 59:2 (p. 263-271)

2. Brickly, James J., Our Educational Goals are a Mishmash, The American School Board Journal, October 1976. (p. 6)

3. Dunning, Stephen, Wanted: A Handful of Rebels, Teacher, September 1976. (p. 14)

4. Fischler, A.S., Science, Process, The Learner: A Synthesis, Science Education 49: 5, 1975. (p. 402-409)

5. Gallup, George H., Eighth Annual Gallup Poll Of The Public's Attitude Toward the Public Schools, Phi Delta Kappan, October 1976. (p. 187-200)

6. Gagne, R.M. The Learning Requirements For Inquiry, Journal of Research in Science Teaching. Vol. 1, 1963. (ps. 144-153)

7. Gega, Peter C., Directions In Elementary School Science, Teacher, November 1976. (p. 59-61)

8. Harbeck, Mary Blott, Is Science Basic? You Bet It Is, Teacher, November 1976 (p. 22-30)

9. Klimes, Rudolf E., Goal Development Planning, Educational Technology, February 1977. (p. 52-54)

10. Klopfer, Leopold, A Structure For The Affective Domain In Relation To Science Education, Science Education, 60:3 July-September 1976. (p. 299-312)

11. Hall, John R., "A Study of The Teaching of Elementary Chemistry, Journal of Research on Science Teaching, 13:6, November 1976. (p. 499-507)

12. Pine and Shapiro, Science Literacy, Teacher, November 1976, (p.57-58)

13. Roman, Varodaiazi V., The Three Planes of Science In Society, Impact of Science on Society 25:1, March 1975. (ps. 9-17)

14. Suchman, J. R., The Illinois Studies In Inquiry Training, Journal of Research In Science Teaching, Vol. 2, 1964. (ps. 230-232)

15. Ziarko, Jon, Predicting Achievement In Science, School Science and Math, November 1976. (p. 571-579)

16. Zhmudskii, A.Z., The 5 Year Plan For Science Is Fulfilled Ahead of Schedule, Soviet Education, December 1976. (p. 95-104

17. OKATA, PT , Humanizing Science To Save The World From Destruction, International Review of Education, No. 22, 1976. (p. 96-105)

II. Papers and Dissertations.

18. Appel, Wuhl and Ree, Cognitive and Affective Outcomes In Children As a Function of Participation In SCIL, An Individualized Version of S.C.I.S. A paper presented at E.E.R.A. Annual meeting, Chicago, Illinois, April 19, 1974. Ed. 097379

19. Blackwood, Paul E., Compilation National Study of Public Elementary Schools. 1961-62

20. Blackwood, Paul E., Science Teaching In The Elementary School, U. S. Department of Health, Education and Welfare, U. S. Government Printing Office, Washington, D. C.

21. Berger, Carl F., Roderick, Stephan, CBTE: A Critical Look Evoluating and Assessing Competencies For Elementary Science Education, A paper presented at the Annual Meeting of the American Educational Research Association 1975. Ed. 109170

22. Bredderman, Ted, Elementary School Science Experience and The Ability to Combine and Control Variables Science Education, 58:4, October-December, 1974. (p.457-469)

23. Ciesla, Jerome, The Effects of Various Formative Evaluation Procedures on Instructional Material Revision In a Large Scale Individualized Science Curriculum Development Project. A paper presented at the Annual meeting of the National Association For Research In Science Teaching 49th Convention San Francisco, California (April 23-25) 1976. Ed 123110

24. Clemmnson, Moore and Jones, Guidelines and Competencies for Elementary Science Education, MSS Information Corporation, N.Y., N.Y. 1974. Ed. 104860

25. Forbes, Roy H. Editor, National Assessment of Educational Progress: Selected Results From the National Assessments of Science: Attitude Questions, U. S. Government Printing Office. Washington, D.C. Ed 127-200

26. Giantrus, Louis Michael, Effects of Sequency on Meaningful Verbal Learning As Proposed By Ausubel With First Grade Students Using Audio-Tutorial Science Lessons, Dissertation Abstracts International, 35:1, 1974. (p. 165A)

27. Guerrcero, Edgar and Bellucci, An E D C Report: Science Teaching in Pennsylvania Public Elementary Schools. Public Educational Development Center, Wilke College, Wilke-Barre, Pennsylvania, 1973. Ed 101934

28. Harley, Lloyd, A Study of the Effect of an Advance Organizer In an Activity-Centered Science Program, Ph D Dissertation, The University of Iowa, Dissertation Abstracts 35:1, 1974. (p. 317A)

28. Herron, Dudley and Others, A Summary of Research In Science Education-1974, John Wiley and Sons Incorporated, New York, New York. December 1975 (p. 104) Ed 116-965

29. Ludeman, Robert, Development of the Science Processes Test, a paper presented at The Annual Meeting of The National Association For Research In Science Teaching, March 1975. Ed. 108-898

30. Mayer, Victor J., Unpublished Evaluation Instrument In Science: A Handbook, ERIC Information Analysis Center For Science, Mathematics and Environmental Education, Columbus, Ohio. April 1974. (322 ps.) Ed 095-015

31. Ogden, William, A Chronological History of Seclected Objectives For The Teaching of Secondary School Chemistry In The United States During the 1918-1922 Period As Reflected In Periodical Literature, a presentation at The Annual Meeting of The National Association For Research In Science Teaching, Chicago, Illinois. April 18 1974. (22 ps.) Ed 095-009

32. Palvia, Howard, Introduction to the Scientific Method (For Grade School Students) A Collection of Objectives, Methods and Tools, a publication of Institut National de Recherche et de Documentation Pedagogigves, Paris, France, 1973. (275 ps.) Ed 123-054

33. Robinson, James T., Critical Issues In Science Education, a paper presented at the Annual Meeting of The Association For Education of Teachers of Science, March 1976. (12 ps.) Ed 127-129

34. Rowe and De Lure, A Summary of Research In Science Education - 1973, John Wiley and Sons, Incorporated, Somerset, New Jersey 1975.

35. Schlessinger, Fred R., A Survey of Science Teaching In Public Schools of The U. S. (1971) Volume 1 Secondary Schools, Eric Information Center For Science, Math, and Environmental Education, Columbus, Ohio 1973. (192 ps.) Ed 093-715

36. Sheehan, Joseph T., Learning Processes In a Basic Science Curriculum, a paper presented at the Annual Meeting of The American Educational Research Association, April 17, 1974, Chicago, Illinois. (10 ps.) Ed 092-400

37. Washton, Nathan, Teaching The Impact of Science on World Technology, a paper presented at the 49th Annual Meeting of the National Association For Research In Science Teaching, April 23-25, 1976 at San Francisco, California. (14 ps.) Ed 125-901

38. Williamson, Stan, Issue In Science Education: Changing Purposes of Science Education, 1976. Ed 127-128

39. _____, State Assessment of Educational Progress In North Carolina, 1973-74, North Carolina State Department of Public Instruction Document, February 1975. (48 ps.) Ed 108-939

40. _____ NSTA Position Statment on School Science Education For The 70's, a paper presented to the NSTA Board of Directors at its annual meeting, July, 1971

41. _____, Guidelines and Standards For The Education of Secondary School Teachers of Science and Mathematics, American Association For the Advancement of Science Commission on Science Education, Miscellanious Publication Number 71-9, Washington, D. C. (ps 1-77).